to showing how the grounds may be made more attractive at slight expense.

Throughout the book the fact is kept constantly before the mind that plants are not fixed and unchangeable objects, but very plastic, gradually changing with changing conditions. Perhaps no text-book ever written is more successful in this respect. "The present forms of vegetation, then, are the tips of the branches of the tree of life. Therefore, the 'missing links' are to be sought behind, not between: they are ancestors, not intermediates." Again: "We really cannot understand plants by interpreting them solely upon their present or obvious characters; the reasons for the appearing of given attributes should be sought in the genealogy, not in the present-time characteristics. It is possible that many of these structures which seem to us to have arisen for the purpose of dispersing the seeds may have originated as incidental or correlative structures, and that it merely so happens that they serve a special but incidental purpose in disseminating the plant. If we once assume that every feature of a plant is adapted to some specific purpose, and that it has arisen by means of the effort of the plant to adapt itself to such purpose, we are apt to find adaptations where there are none. We are really throwing our own thoughts and feelings into the phenomena; and we are developing a superficial method of looking at nature."

Occasionally one notices such slips as are inseparable from first editions, but the errors are remarkably few and of such a nature as to admit of easy correction in the next edition, which we understand is already in preparation. Undoubtedly, the book will open the eyes of a great many people to the delights of meadows and woodlands, and also to the many interesting things that may be found even in a window garden or in the smallest dooryard. It deserves to have a very wide reading, and it is not too much to wish that it might find its way into the hands of a majority of the teachers in our common schools.

ERWIN F. SMITH.

Morphology and Development of Astasia asterospora and Bacillus tumescens. — In recent years several well-known writers, like Bütschli, Fischer, and Migula, have given us their views on the bacterium cell. Since these writers do not agree as to the structure and nature of all the parts, Arthur Meyer[1] has made a careful study

[1] *Studien über die Morphologie und Entwickelungsgeschichte der Bacterien, ausgeführt an Astasia asterospora A. M. und Bacillus tumescens Zopf.* Flora, **84**: pp. 186–248, pl. 6.

of the life history and morphology of *Astasia asterospora* A. M. and, incidentally, *Bacillus tumescens* Zopf. The paper, in addition to its value as a morphological study, contains many interesting details on methods of staining to differentiate different parts and clearly bring out the structure of the spores, nucleus, vacuoles, and mucilage.

The organism was obtained from boiled carrot and isolated by heating the spores to 90° C. for three minutes. On sterilized carrots, a gray, lustrous, gelatinous mass grows along the line of inoculation, and in five days spreads over the whole surface, with numerous gas bubbles. Other culture media used were as follows: peptone cane sugar solution, asparagine solution, peptone meat extract. In cane sugar solution, the organism produced 25–60 per cent of carbon dioxide, the remainder being a combustible gas, chiefly hydrogen. In a normal nutrient solution, the medium became cloudy in fourteen to eighteen hours. During this period the rods are actively motile (period 1). Motility ceases in twenty-four hours, small masses of bacteria occur, and some gas is formed. The former increase in size, becoming large and flaky, and rise to the surface with the contained gas. In fifty hours gas development has ceased entirely. The end of the period occurs in forty-eight hours (period 2). In forty-eight hours the gelatinous flakes drop to the bottom of the flask, and spores are abundant (period 3). In sixty-four hours isolated ripe spores occur (period 4).

The author determined that it does not produce a diastatic ferment capable of dissolving starch, nor one that is capable of reducing cane sugar, but in all probability an enzyme is formed which acts upon cellulose, since the middle lamella of the cell wall of carrot is dissolved. It is also an acid-producing organism; the amount is greater in normal nutrient solution than when grown in asparagine solution.

The morphology and development of Astasia may be summarized as follows: The spore germinates in a normal nutrient solution, when kept at 30° C., in about six hours. The rod coming from the spore is at once motile; by repeated subdivisions other rods are formed. In the course of twelve hours single motile rods cease to move, and the development of mucilage proceeds. One may also notice that motile masses move through the medium, and these approach a mass and leave it again. This is kept up till the "swarmer" becomes inactive. In this way round colonies are formed and with the contained gas rise to the surface, where they collect as mucilaginous flakes. Generally the Astasia occurs as a

single rod. Rarely are the rods placed end to end, forming a thread imbedded in mucilage. Mucilage is not formed by the transformation of the cell wall. Meyer further demonstrates that an abundance of mucilage is formed between the two rods in the process of cell division, but is difficult to demonstrate during the early stages. In the motile stages it occurs only between the two rods, but in the resting stage mucilage rapidly surrounds the whole organism. It may be noted, also, that a protoplasmic band connects the two rods in Astasia and some other species examined. It is probable that protoplasmic connection will be found in bacteria where rods form chains, or in motile forms which consist of several rods. The bunched flagella are lateral, and occur singly or a pair near the end, and occasionally a third bunch below. The third bunch, in most cases, occurs before division. Vacuoles may be made out in stained as well as unstained preparations, and these are axillary, much like those of Eumycetes. These differ in form as well as number. The Astasia vacuole was compared with that of Hypomyces, in which glycogen was found. The vacuole of dried Astasia preparations stains readily, the peripheral portion more intensely than the cytoplasm. It is to be expected that the vacuoles of bacteria should often contain concentrated reserve material.

The bacterial protoplast has some further points of similarity with Eumycetes. It has one or more nuclei in the cell, but not Bütschli's nucleus. Bütschli considers that a "Centralkörper" is the main part of the protoplast, and that cytoplasm is reduced to a minimum. Meyer's nucleus is a much smaller body. With staining reagents it behaves like the nucleus of fungi. In cell division the cytoplasm contracts, and a nucleus passes into each part. In one hour a new cell is formed, each rod containing a nucleus. The nucleus is not connected with the formation of the cell wall. *Bacillus tumescens* forms its spores in the same way that Astasia does. One-half of the cytoplasm of the sporangium becomes clearer, the other half granular. In a short time the somewhat more refractive fertile cytoplasm of the sporangium contains a nucleus, and the whole is separated from the homogeneous plasma by a delicate line. The young spore refracts light strongly. A wall forms about it, and at maturity it is provided with two walls. In Astasia the outer wall (extine) is provided with projections and the intine is smooth. A strongly refractive rod may also be observed in the interior. The method of spore formation in these species may be compared with that taking place in Ascomycetes. Astasia, however, never branches,

but perhaps true branching occurs in some species closely related to this organism. Motile masses are never produced by the Ascomycetes, a difference that constitutes a valid point of separation. Meyer discusses the relationship of Schizomycetes to this group, and proposes the following classification of the

BACTERIACEÆ.

BACTERIEÆ. Cells motionless. *Bacterium.*
BACILLEÆ. Flagella arising from the whole surface. *Bacillus.*
PSEUDOMONATEÆ. Flagella polar.
(*a*) Normally with a single flagellum. *Bactrineum.*
(*b*) Normally with more than one flagellum. *Bactrilleum.*
ASTASIEÆ. Flagella in groups, lateral.
Flagella in one or two groups, one-celled rods. *Astasia.*

L. H. PAMMEL.

Brown Rot of Cruciferous Plants. — Erwin F. Smith, who has made an exhaustive and careful study,[1] concludes that *Pseudomonas campestris* is responsible for the brown rot of cabbage and other cruciferous plants. There certainly seems to be no doubt that the organism described somewhat briefly by the writer several years ago is identical with that described by Smith. It produces a distinct browning in the bundles, the bacteria having a fondness for the alkaline sap of the bundles and little attraction for the acid parenchyma. Infections were obtained by needle punctures, by means of slugs and insect larvæ, and through the water pores situated on the teeth of the leaves. Infections through ordinary stomata were not obtained; the waxy bloom on the cabbage leaf protects the plant. It is probable that a majority of the natural infections in the field take place above ground, the disease being transmitted from diseased to healthy plants and from one part of a plant to another, as the result of the visits of insects and other small animals. The organism grows well in feebly alkaline beef broth. Gelatin is slowly liquefied. In addition to these media, Smith cultivated it on cabbage broth, litmus cabbage broth, agar, potato, carrot, beet, onion slices, orange segments, cocoanut flesh, etc. In cruciferous substrata it grew promptly and with great vigor, except on the horse-radish, where the growth at first was slow. On steamed cauliflower the organism was brightest, approximately lemon yellow or light cadmium; it was

[1] Erwin F. Smith, Pseudomonas campestris (Pammel): The Cause of a Brown Rot in Cruciferous Plants. *Centralb. f. Bakt. u. Parasitenk.*, Abt. ii, Bd. iii, pp. 284–291, 408–415, 478–486, Pl. VI. 1897.